Biscayne Bay Minimum Flows and Levels

December 17, 2003

Welcome

Introduce yourself.
We're here to share information.

Minimum Flows & Levels for Biscayne Bay

Joel VanArman

Water Supply Department

TAG Meeting
Miami, Florida
December 17, 2003

Overview and Purpose

- Provide brief introduction
- Define MFLs and significant harm
- Explain why they are being developed
- Major Participants
- Schedule for Completion
- MFL Priority List
- Contacts for additional information

What are Minimum Flows and Levels?

- Definitions provided by statute
  - Minimum Flows
  - Minimum Levels
- Levels needed to protect water resources from significant harm, based on (at least in theory):
  - Identification of resources and their functions
  - Selection of appropriate/sensitive resource and function
  - Determination of technical relationships between water levels and resource functions
  - Identification of a “significant harm” threshold

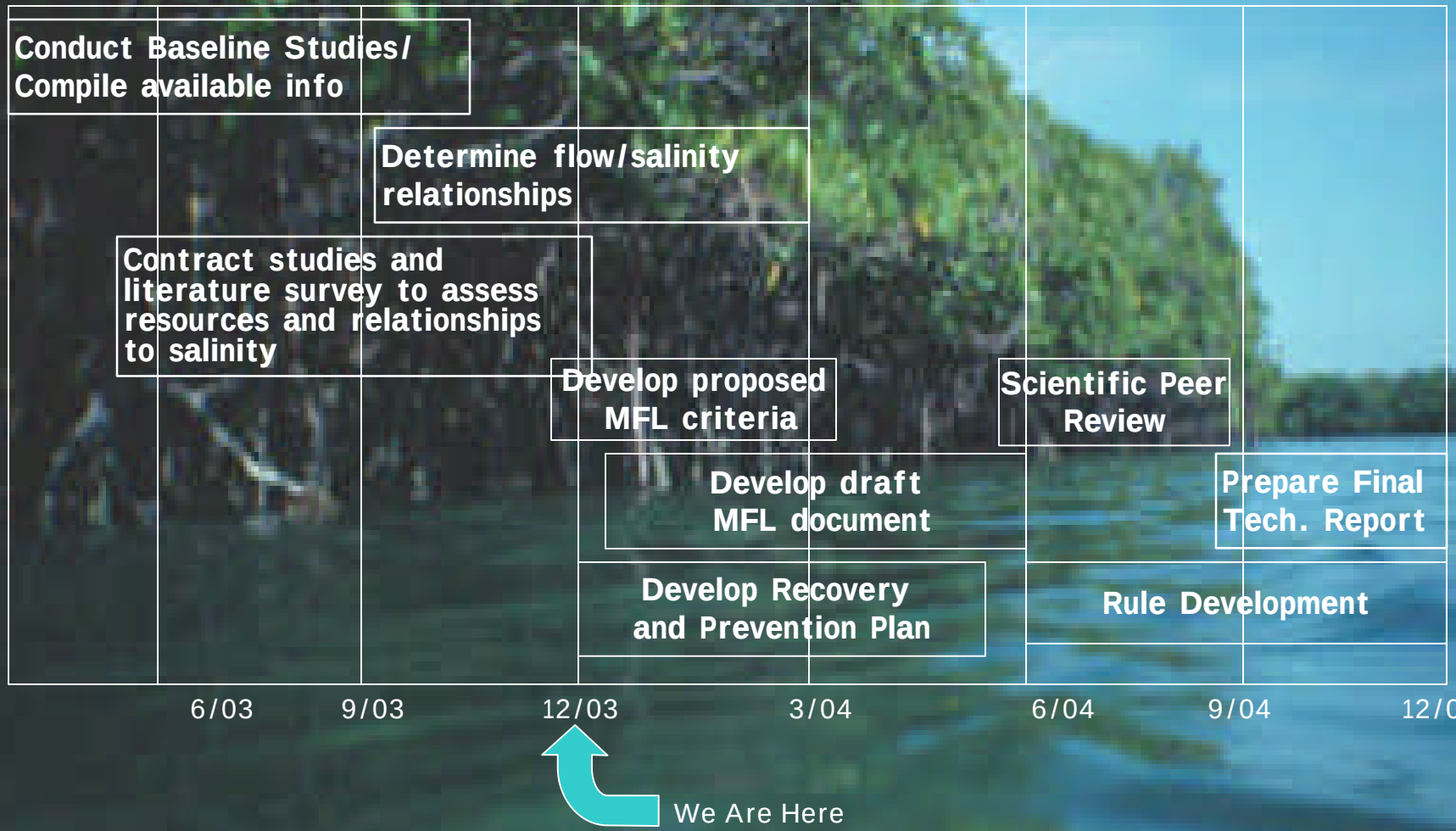
Why Are We Developing These Criteria?

- Required by Legislation since 1973
- Other Districts are doing it
- CERP and LEC Water Supply Plan may need criteria as performance measures
- District's regulatory program need criteria as a basis for Consumptive Use Permitting, rulemaking and reservations

Major Participants

- WMDs, FDEP, Parks (state and federal), Local Governments and Utilities, Interest Groups
- Closely intertwined with:
  - SFWMD Regulatory program
  - Research Efforts
  - LECRWSP
  - NOAA, NPS, USGS, RSMAS, FIU, Miami-Dade County
  - CERP – BBCW, C-111, Mod Waters, BBFS, etc.
- Comments Provided by:
  - Other agencies- FDACS, FFWCC, USFWS
  - Private interests, agricultural users and conservation groups by way of advisory committees, public meetings, workshops and comments

Schedules for South Bay MFL Criteria Development, Recovery Plan, and Rulemaking



MFL Priority Water Body List*

- **2004**
  - Biscayne Bay
- **2005**
  - Florida Bay
- **2006**
  - Kissimmee River and Lakes
  - Estero Bay
- **2007**
  - Loxahatchee River Tributaries

*Subject to change/revision each year

Contacts

- Murray Miller
  Project Manager

  Joel VanArman
  MFL Supervisor

- Rick Alleman
  Research Coordinator

  Susan Ray
  Research Supervisor

Soon to Come: Biscayne Bay MFL Web Site at:

sfwmd.gov => Major Projects => Minimum Flow and Levels => Biscayne Bay

Role of this group

- Provide technical feedback to District staff
- Composed of public org. stakeholders
- Assist with details (e.g. locating publications or data)
- **District's Governing Board adopts final rule**

Today's Talking Points: MFL Process

- Gather information
- Geographic considerations
- Document existing character
- Select an approach

Information Gathering

- "Best **available** information"
- Data and results in hand from DERM, BNP, literature, etc.
- Consultant assisted

Summary of Last Meeting

- Example: Crocodiles (Mazzotti)
- Pink Shrimp
- Osmo-regulation/life cycle functions
- Candidates: gray snapper, redfish, sea trout, killifish, gambusia
- Create habitat nearshore (multiple species)
- Refugia concept (possibly oysters)

Current Effort

- Contracted literature survey/expert interviews
- Reviewed MFLs in SFWMD/Florida
- Searched and evaluated any new information
- Applied criteria
- Make recommendations on approach

Consultant's Recommendations

- Sub-divide Bay into regions
- Approaches including indicator species, VECs, community index, food web
- South Central sub-region: VEC from among several species

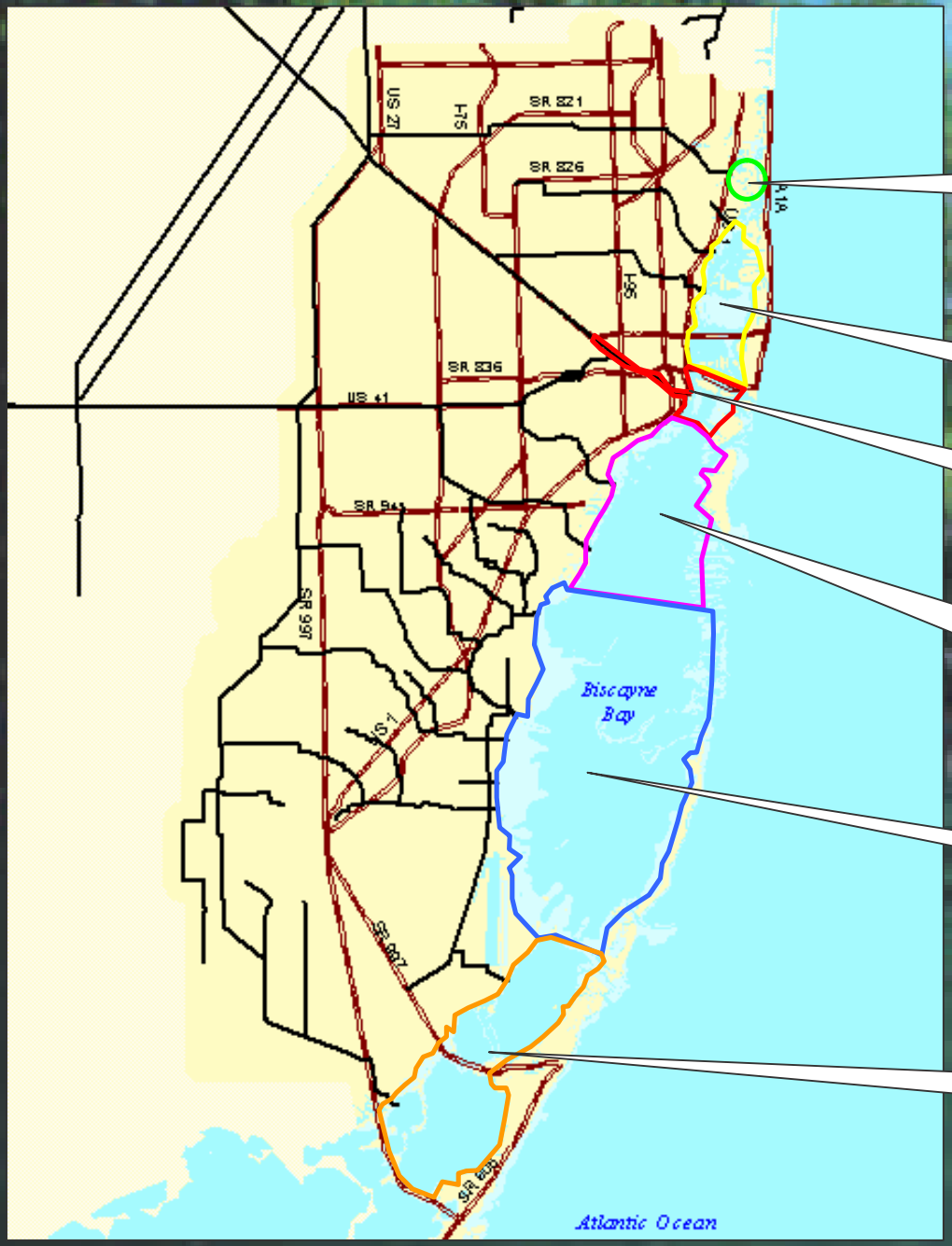
Final Comments

- (Interviewees) *Thank you* !
- Final draft under review
- Available in January

Role of geography

- Differing areas of the Bay possess different communities, character, watersheds, hydrology, hydrography, etc.
- Six areas with differing needs
- Resources not available to develop criteria for each simultaneously

MFL Regions of Biscayne Bay



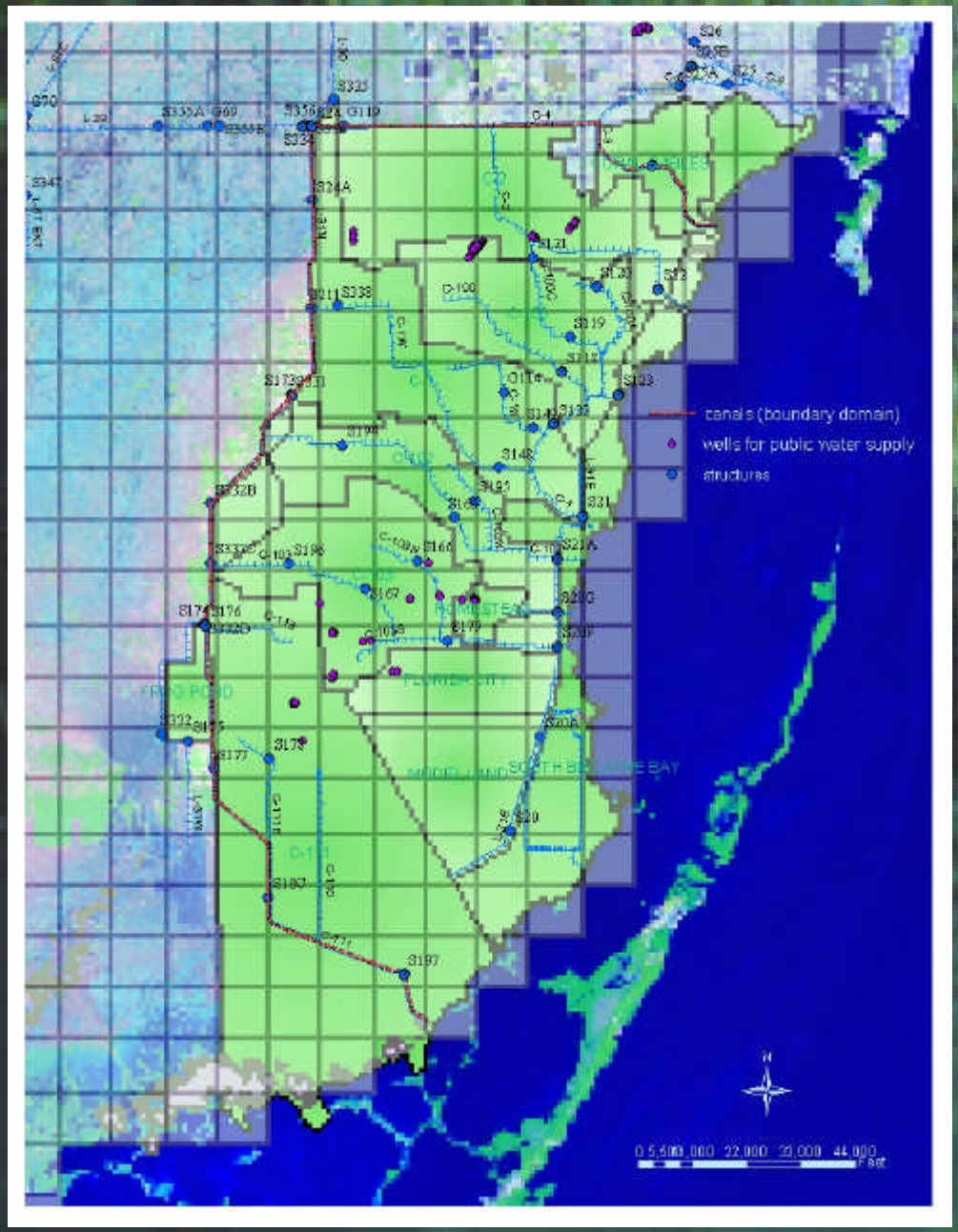
- Snake Creek/Oleta River
- North
- Miami River
- North Central
- South Central
- South

MFL Criteria Development

- South Central (aka. South Bay)
  - Coincides with primary area of the CERP BB Coastal Wetlands Project
- South (aka. Far South)
  - Remaining area affected by CERP BBCW and C-111 Spreader projects
- North Central (aka. Central Bay)
- Miami River
- Snake Creek/Oleta River
- North

Southern Miami Dade County Watershed Rainfall and Water Budget Analyses

Christiana G. Aguirre

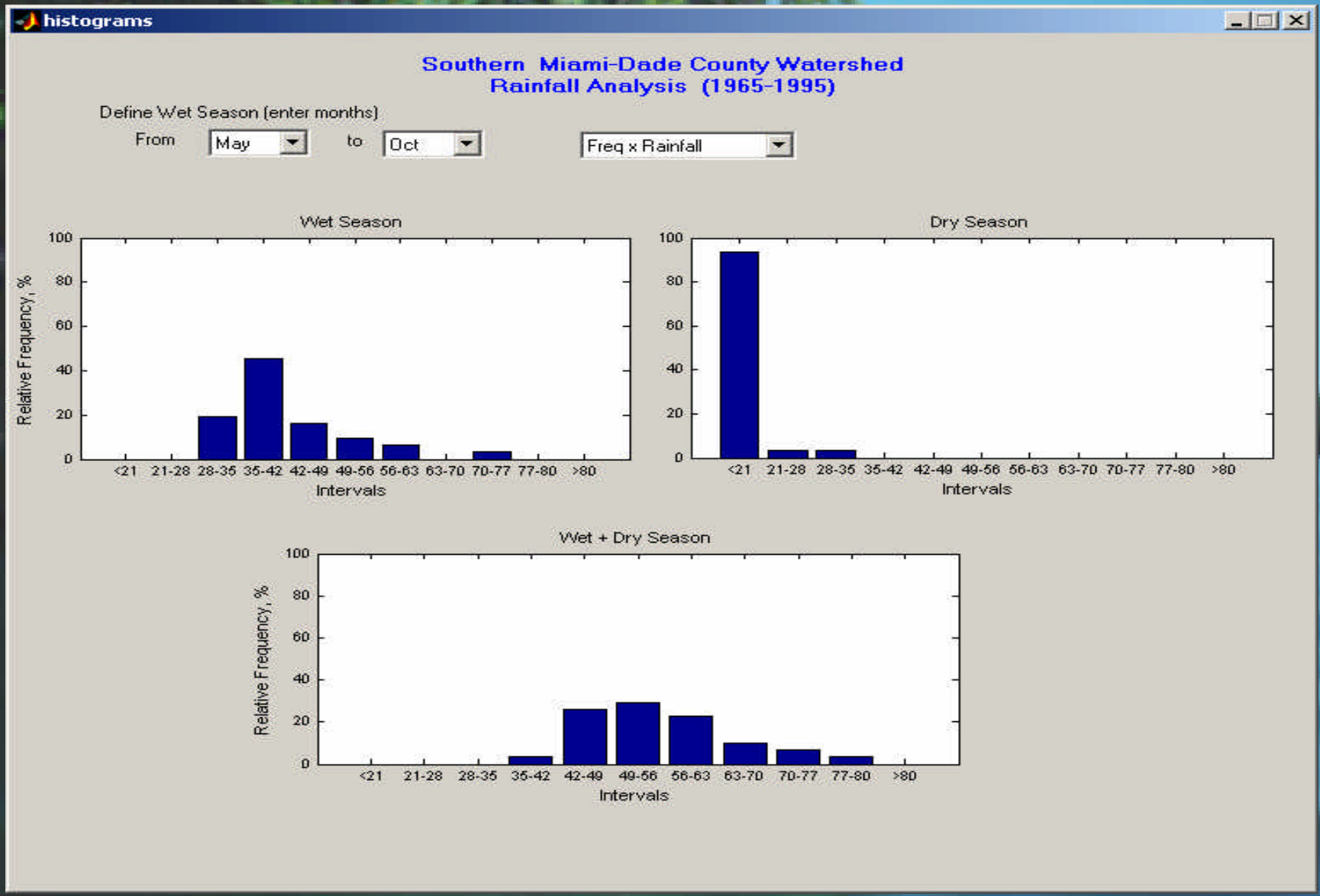


Study area: Southern Biscayne Bay Watershed

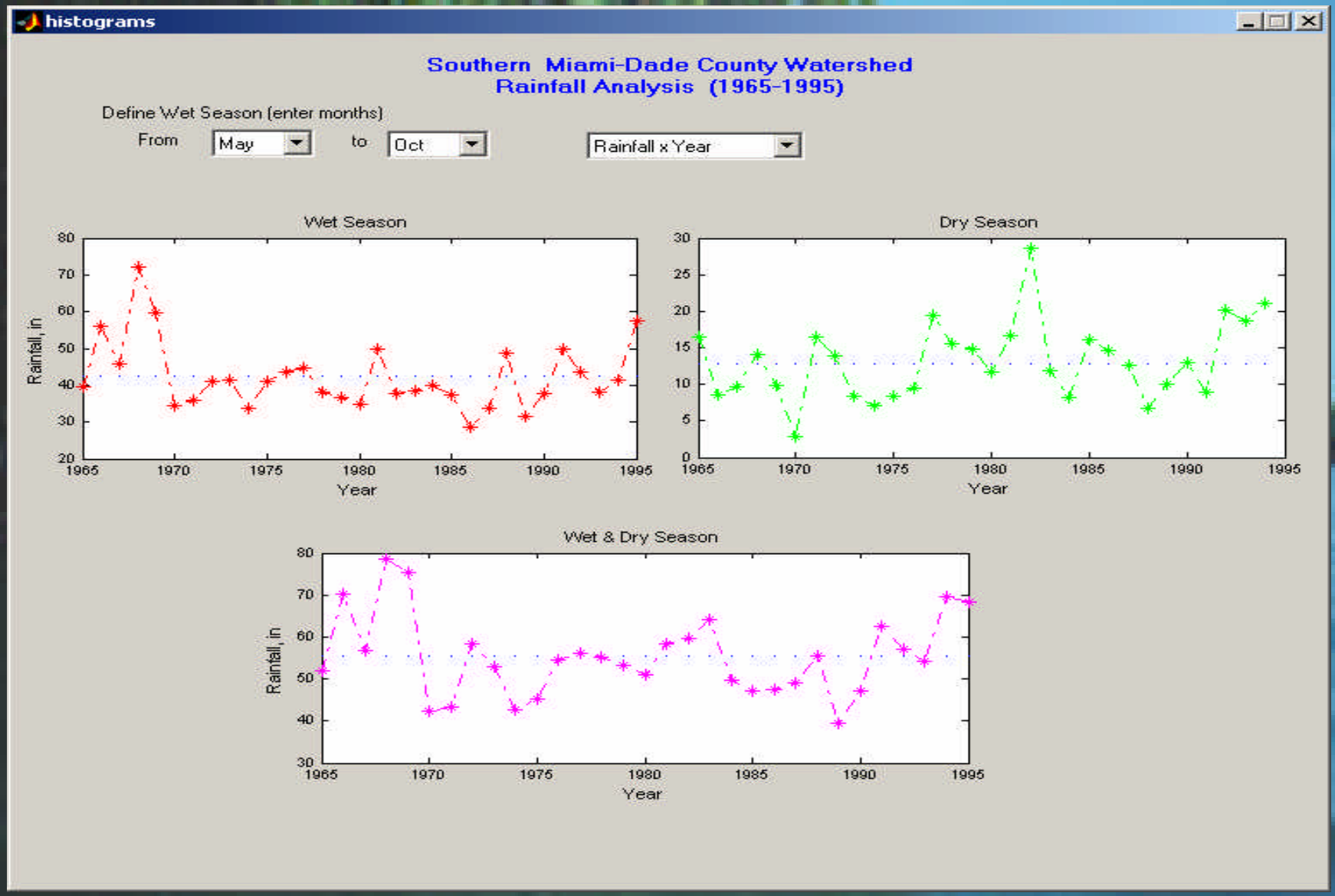
Input Data

- Data from SFWMM – 95 Base Run
  - Rainfall
  - Evapotranspiration
  - Structure (canal) flow
  - Groundwater flow
  - Overland flow
  - Well pumpage
  - Levee seepage

Rainfall Frequency Distribution



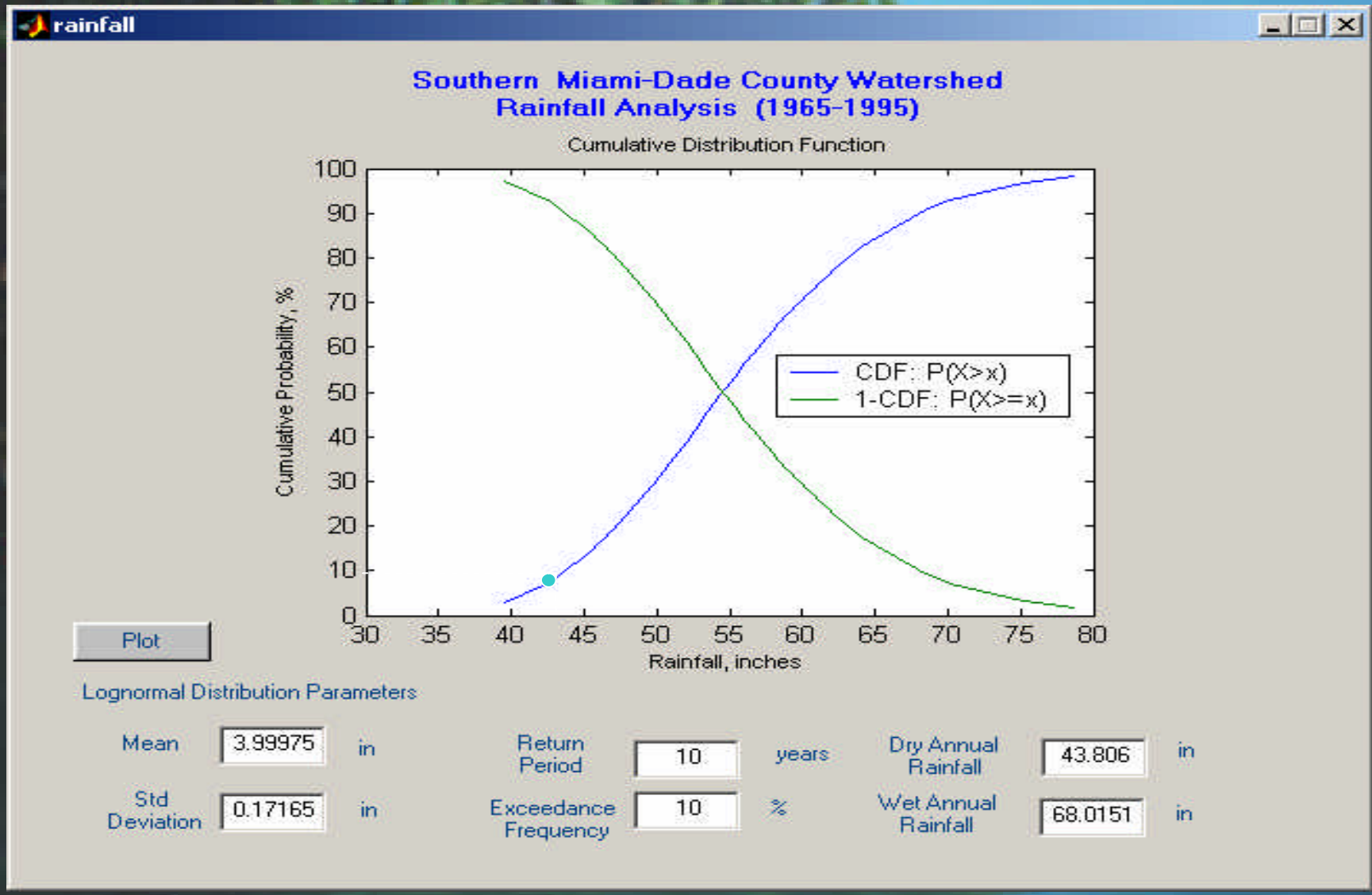
Rainfall Analysis



1-in-10 Year Dry Rainfall

- 1-in-10 Year Drought is a drought of such intensity, that it is expected to have a return frequency of once in 10 years
- 1-in-10 Year Dry Rainfall is defined as having probability of 1/10 receiving that amount of rainfall or less in any year

1-in-10 Year Dry Rainfall



1-in-10 Year Dry Rainfall

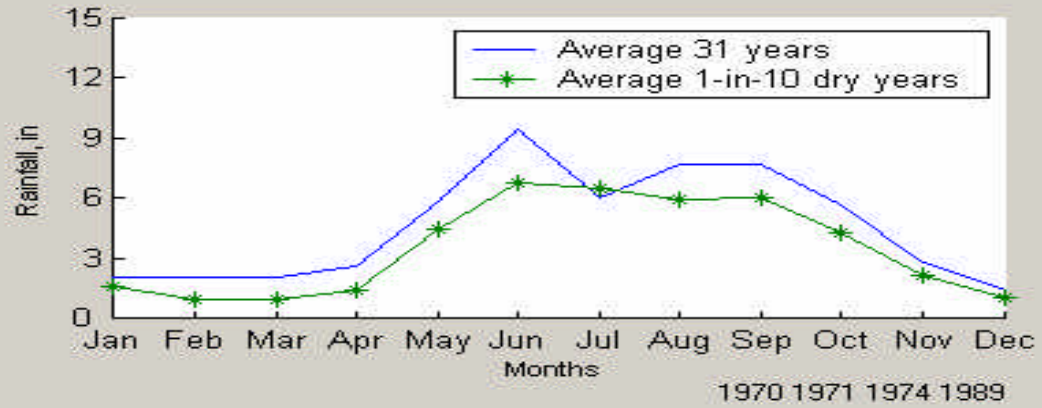
Year	Rainfall (in)	% difference from 1-in-10 year dry rainfall **
1970	42.3988	-3.21%
1971	43.4428	-0.829%
1974	42.6529	-2.632%
1989	39.5189	-9.786%

*** 1-in-10 year dry rainfall = 43.806 in*

Rainfall Analysis

mean_year

Southern Miami-Dade County Watershed
Rainfall Analysis (1965-1995)



1970 1971 1974 1989

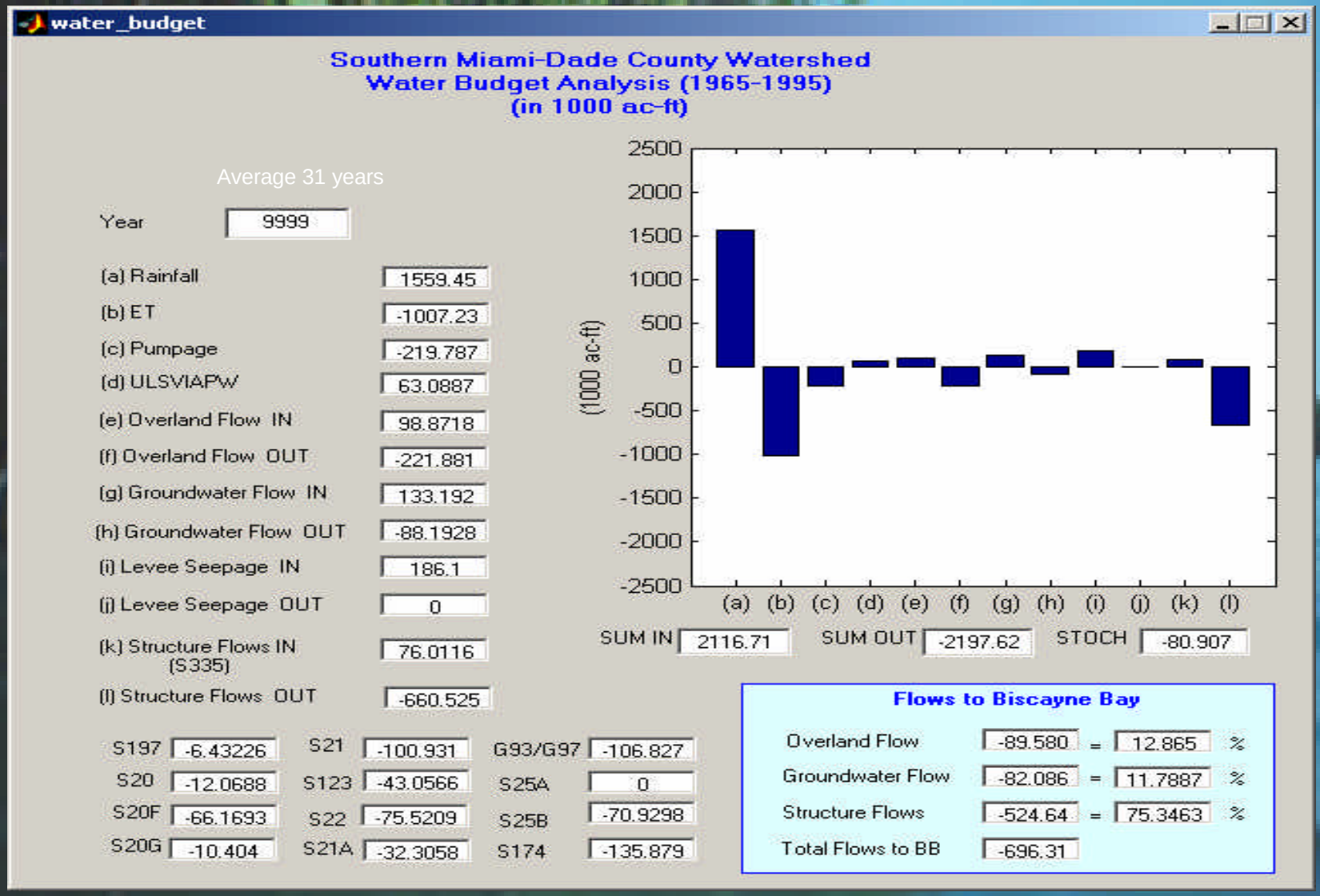
Period 1965-1995 | Plot

Total	55.3782	in
Mean	4.61485	in
Median	4.23088	in
Variance	7.58276	in2
Minimun	1.40818	in
Maximum	9.40969	in
Skewness	0.348599	
Kurtosis	1.67069	

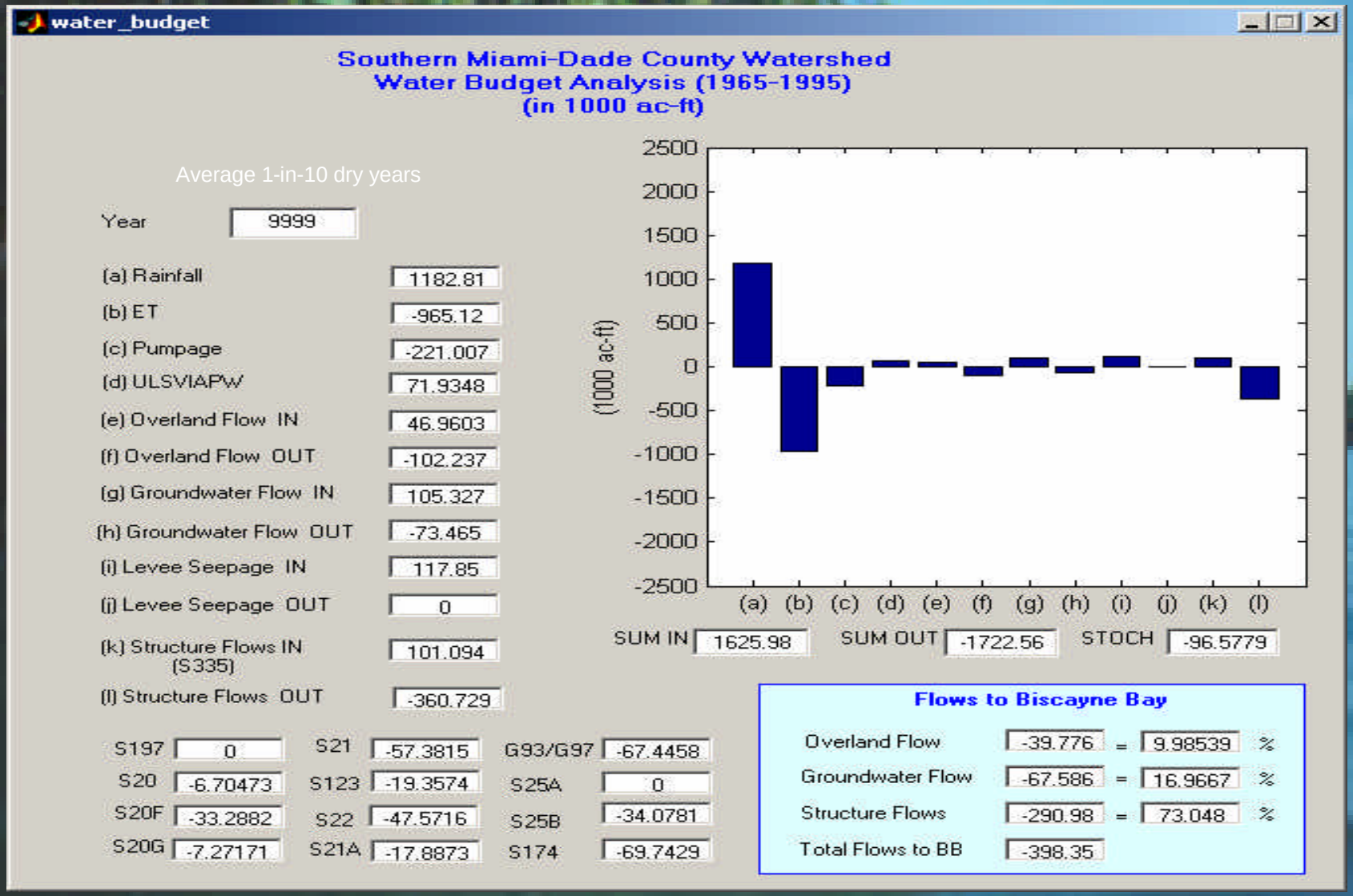
Enter year | 9999 | Plot

Total	42.0034	in
Mean	3.50028	in
Median	3.22066	in
Variance	5.63612	in2
Minimun	0.947765	in
Maximum	6.79341	in
Skewness	0.182897	
Kurtosis	1.31944	

Water Budget Analysis: Average of 31 Years



Water Budget Analysis: Average Four Driest Years

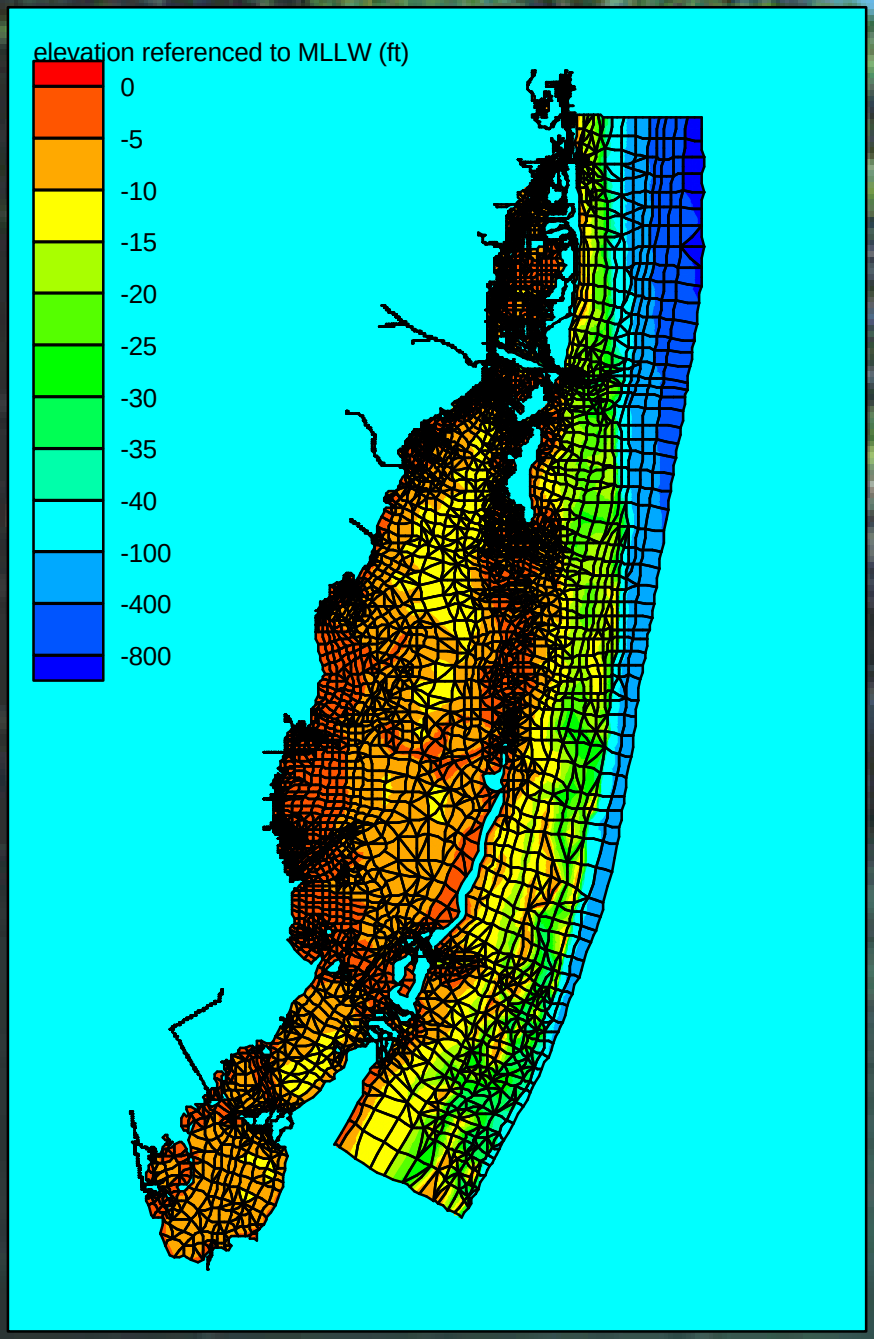


Biscayne Bay TABS-MDS Model

Christiana G. Aguirre

TABS-MDS model

- TABS-MDS (Multi-Dimensional, Sediment) is a finite element, hydrodynamic model
- Based on RMA10, written by Dr. Ian King of Resource Management Associates (King 1993)
- Advantages :
  - easy to handle complex geometries
  - easy to incorporate different materials (bottom types)
  - easy to handle complex boundary conditions
- Both unstructured and implicit
- GUI: Surface Water Modeling System (SMS)
- Easy to incorporate different model parameters



TABS-MDS mesh covers the entire Bay system

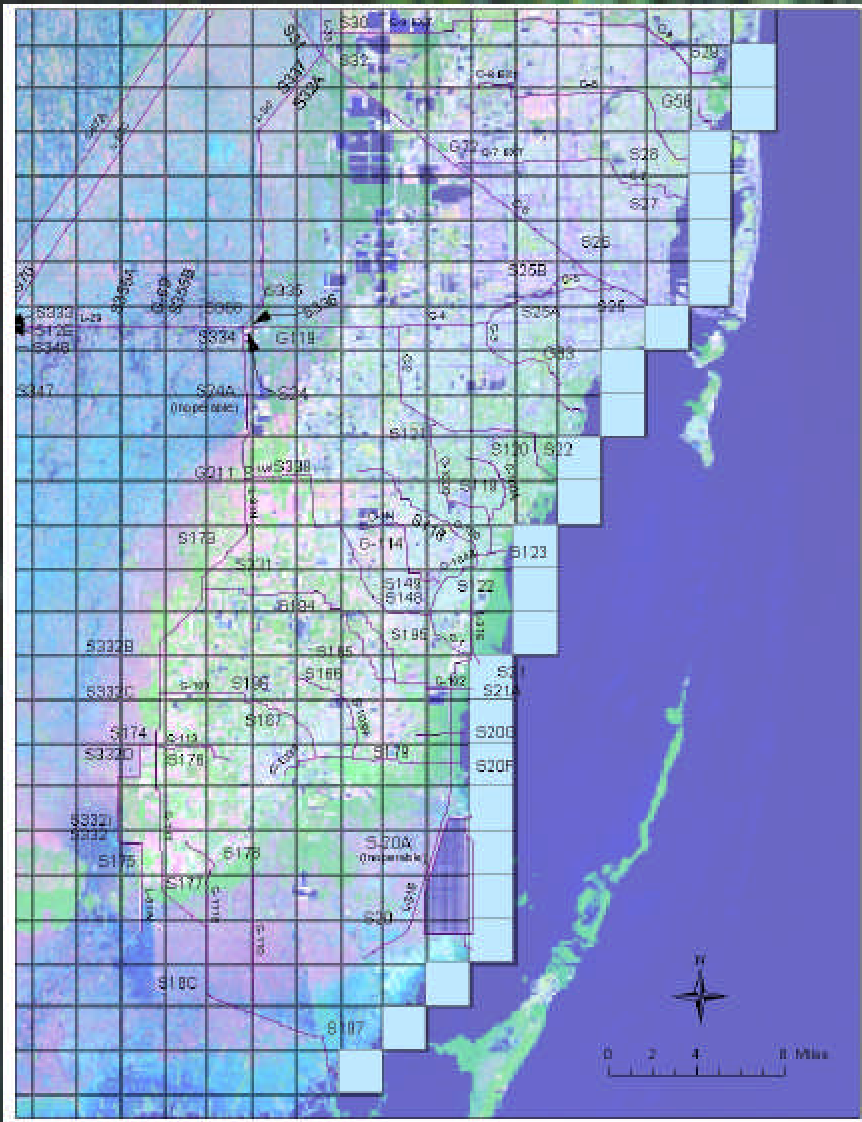
Use of TABS-MDS for MFLs

- Predict average relative changes in nearshore salinity patterns from changes in freshwater inflow quantity and distribution
- Predict rate of change in salinity patterns based on freshwater inflow rates or timing
- Provide insight about Bay physics
- Predict percentage of time that salinity levels are above/below specified values
- Predict salinity level at a specified location as a function of time

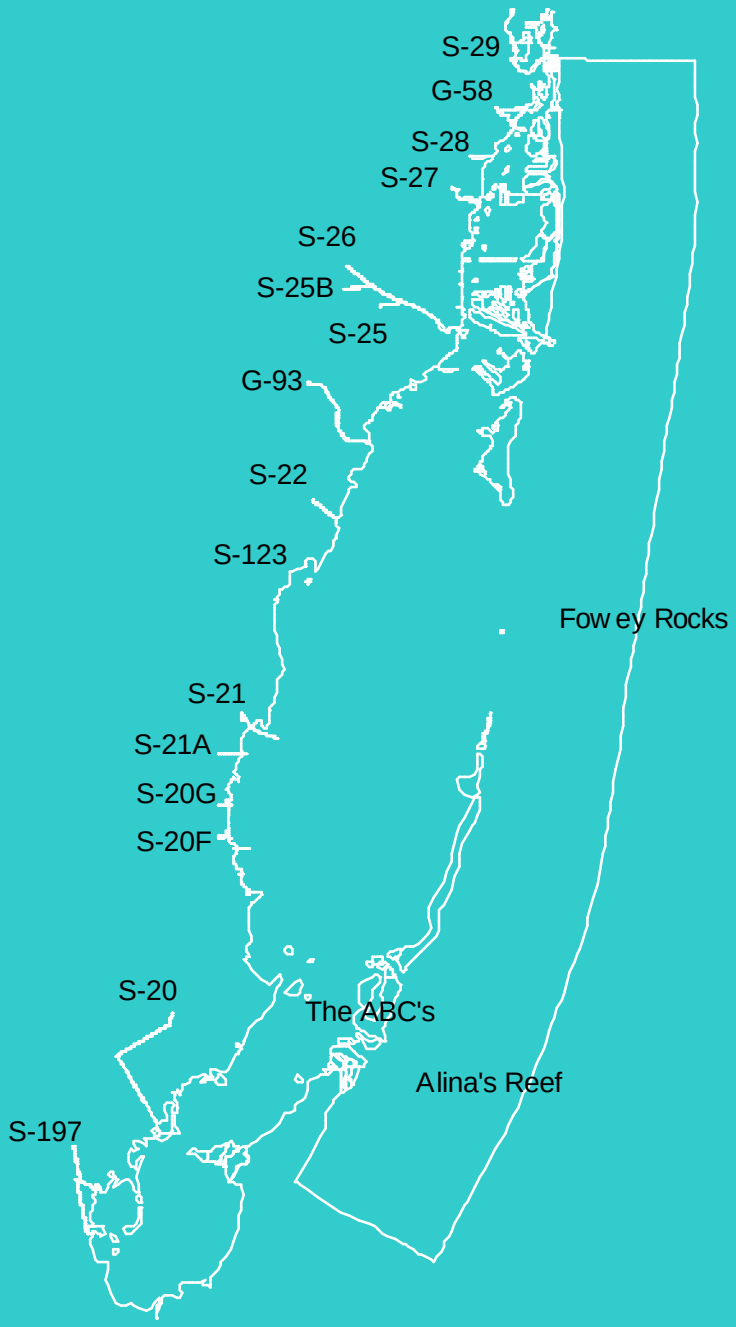
Proposed Model Set up for MFLs

- Base year=flows and rainfall from SFWMM2000 (36 yr. average)
- Drought year=flows and rainfall average with <43.8 in. annual rainfall (~5 years, e.g. 1971)

Model Boundary Conditions: Rainfall & Evaporation

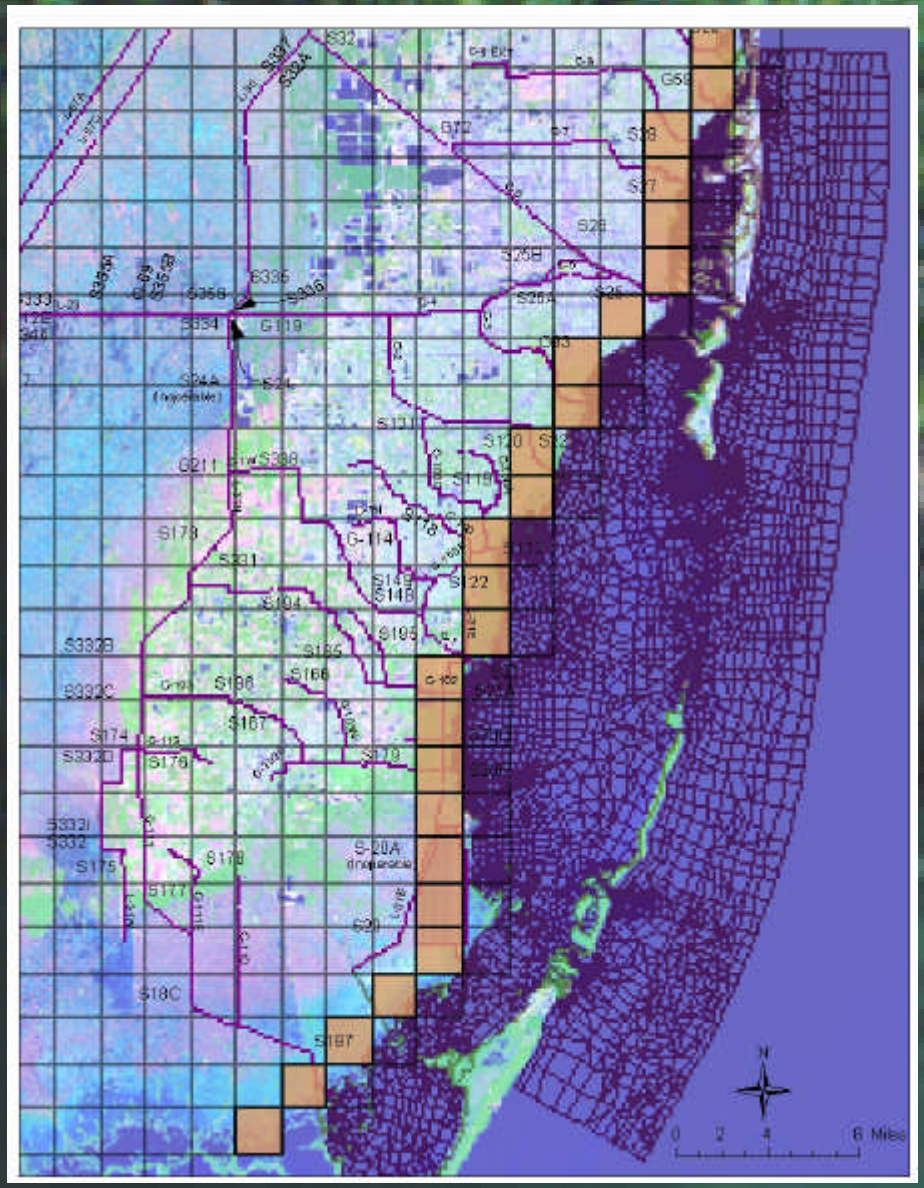


- BBFS Rainfall
  - Daily observations
  - 1997-1998
- Proposed Rainfall
  - SFWMM 2000 Base Run
  - 1965-2000
  - average from cells
- BBFS Evaporation
  - Daily observations
  - 1997-1998
- Proposed Evaporation
  - Hialeah (DBHYDRO)
  - 1948-1998



Model Boundary Conditions: Surface Inflow

- BBFS:
  - Modified DBHydro
  - 1997-1998
  - daily values
- Proposed:
  - SFWMM 2000 Base Run
  - 1965-2000
  - average values



Model Boundary Conditions: Groundwater Inflow

- BBFS:
  - USGS SEAWAT Model
  - 1997-1998
  - percentage values
- Groundwater inflow:
  - SFWMM 2000 Base Run
  - 1965-2000
  - average values

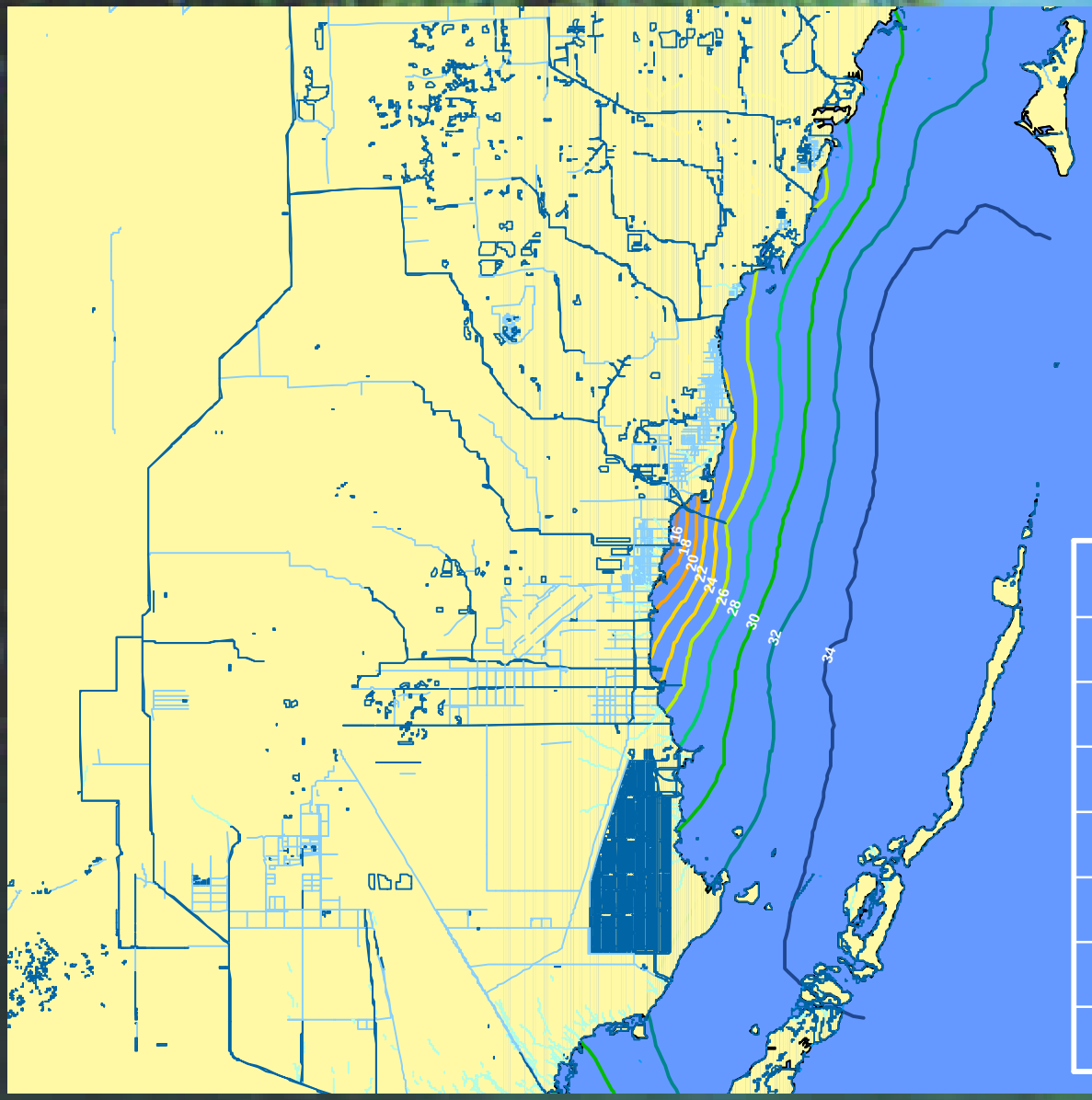
Biscayne Bay MFL Base-Run

- Simulation period – 1 year

Mesh	BB FS
Offshore tidal boundary	BB FS
Offshore salinity	BB FS
wind	BB FS
rainfall	SFWMM
evaporation	DBHYDRO
structure inflows	SFWMM
groundwater inflows	SFWMM
offshore currents	BB FS

Plan to use available data, for example:

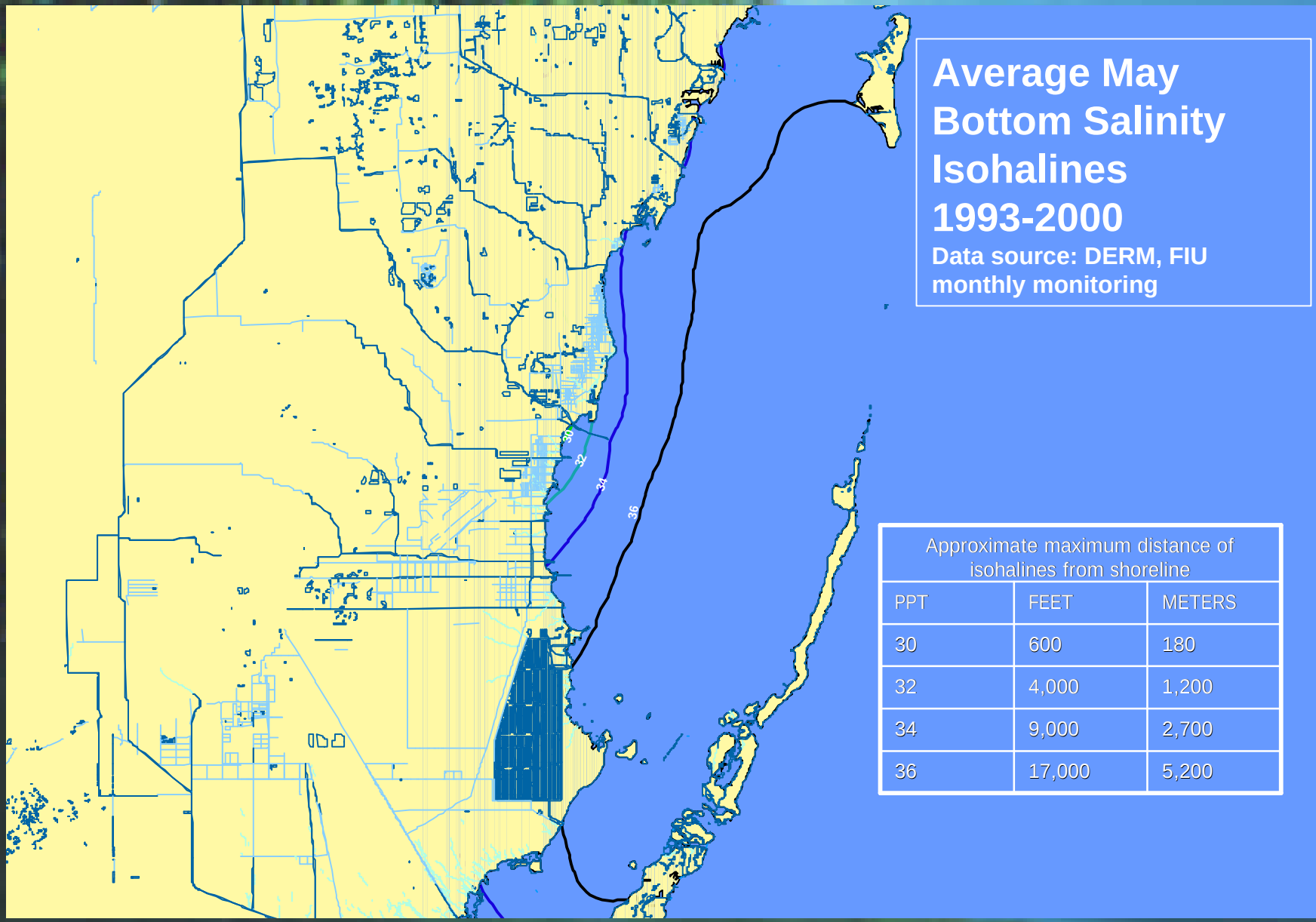
- Salinity monitoring data
- Meeder *et al*. creek and water budget results
- Browder *et al*. inshore fish community results
- Wingard *et al*. paleoecological results



Average September Bottom Salinity Isohalines 1993-2000

Data source: DERM, FIU monthly monitoring

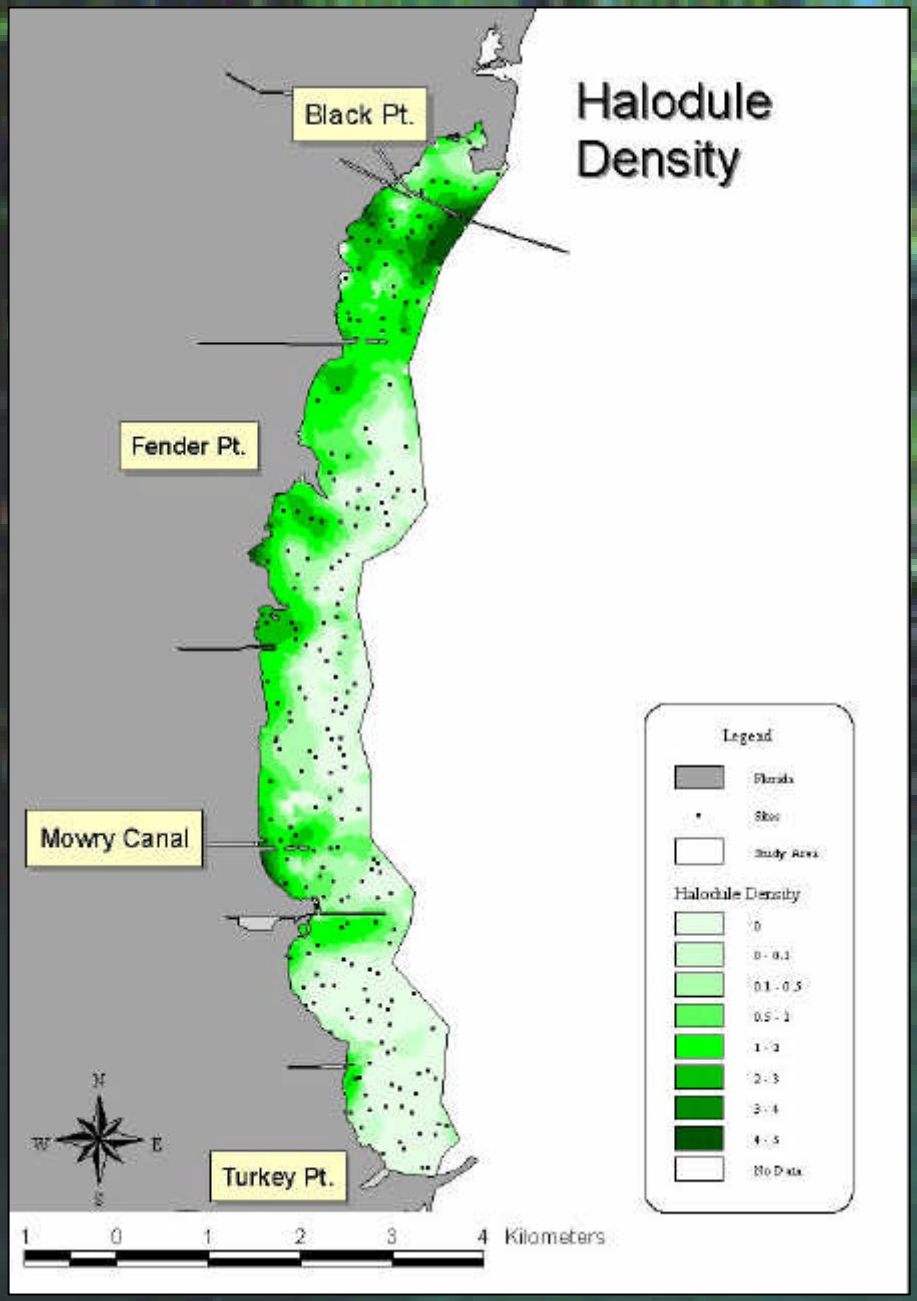
Approximate maximum distance of isohalines from shoreline		
PPT	FEET	METERS
16	1,000	300
18	2,500	750
20	4,000	1,200
22	6,000	1,800
24	8,000	2,500
26	1,0000	3,000



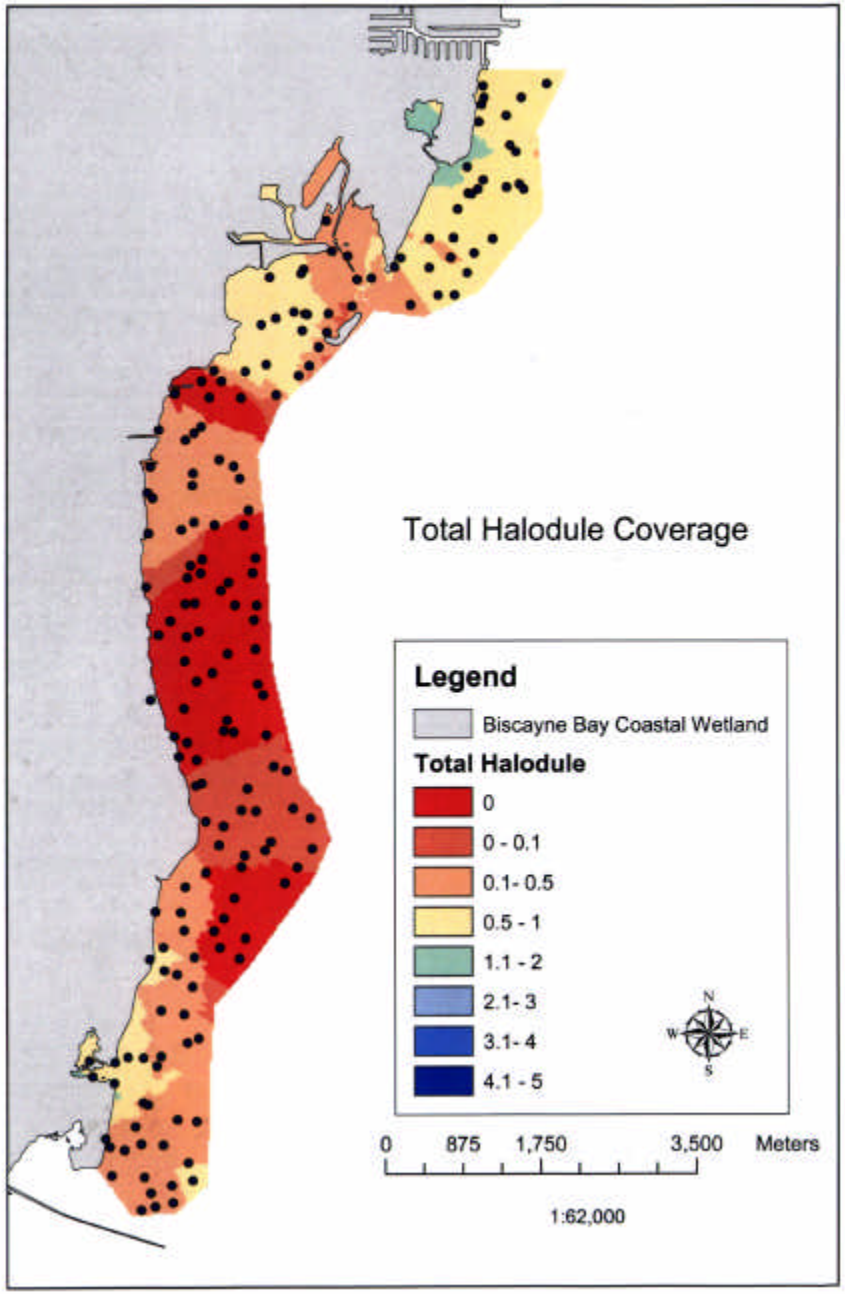
Average May Bottom Salinity Isohalines 1993-2000

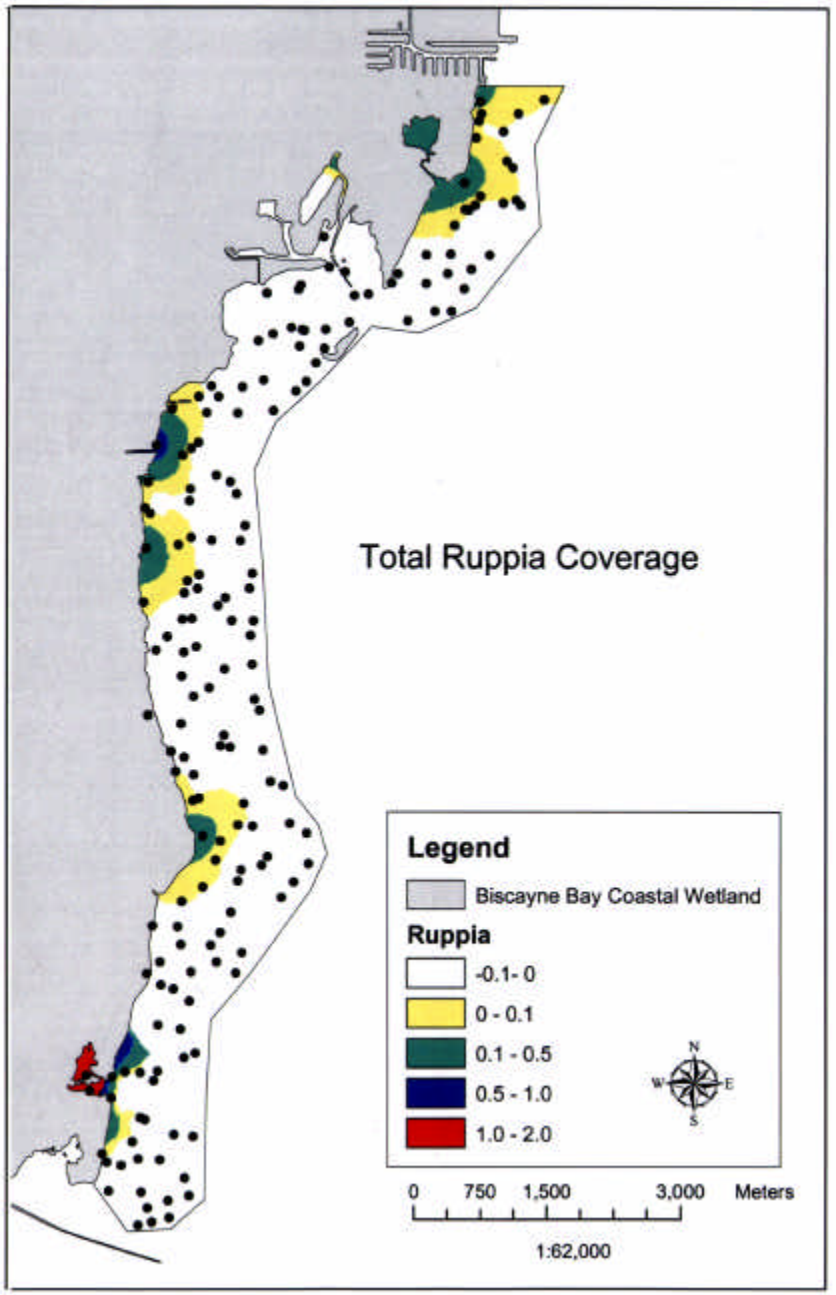
Data source: DERM, FIU monthly monitoring

Approximate maximum distance of isohalines from shoreline		
PPT	FEET	METERS
30	600	180
32	4,000	1,200
34	9,000	2,700
36	17,000	5,200



Data now being collected by Meeder, Mir, *et al.* document the presence of viable *Halodule* seagrass beds nearshore the study area.


Total Halodule Coverage
Legend
Biscayne Bay Coastal Wetland
Total Halodule
0
0 - 0.1
0.1- 0.5
0.5 - 1
1.1 - 2
2.1- 3
3.1- 4
4.1 - 5
N
W
E
S
0
875
1,750
3,500
Meters
1:62,000


Total Ruppia Coverage
Legend
Biscayne Bay Coastal Wetland
Ruppia
-0.1- 0
0 - 0.1
0.1 - 0.5
0.5 - 1.0
1.0 - 2.0
N
W
E
S
0
750
1,500
3,000
Meters
1:62,000

Historical Context

- Critical section in the document
- Characterize historical freshwater inputs and resources to compare with present conditions and proposed MFL criteria
- Provide a perspective for restoration efforts and water reservations
- How historical conditions analyses were used in St. Lucie and Caloosahatchee systems
  - historical watershed features, runoff characteristics and aquatic resources were described/estimated based on historical data and documents, comparisons with other systems and modeling results
  - compared and contrasted with present conditions
  - provided a basis for determining restoration needs, but were *not* the basis for establishing MFLs
  - MFL criteria were based on protection of *existing resources* from significant harm

Exclusions and Considerations

- MFL law provides for **Exclusions**:
  - artificial water bodies;
  - water bodies that have been irrevocably altered so that resource functions have been lost
  - small water bodies that are not of regional concern (protected by other criteria).
- MFL law also provides for **Considerations**:
  - system has been modified to the extent that full restoration is not feasible or even desirable;
  - allows establishment of management targets that
    are consistent with existing resources

Biscayne Bay Historical Context

(pre drainage -- exact features are debatable)

- Greater Surface water inflows
  - Coastal rivers with rapids
  - Overland flow across wetlands
  - “Tidal” creek flow
  - What were the seasonal flow patterns?
- Greater Groundwater inflows
  - Freshwater springs in the bay — seasonal?
  - Groundwater contribution to rivers, creeks and wetlands
  - Driven by higher water tables

Historical Context (cont.)

- Northern Bay
  - Less exchange with ocean
  - More colored (dark) water
  - More oyster bars and less seagrasses?
- Southern Bay
  - More stable persistent, low-salinity conditions; more oysters, redfish, tarpon and seatrout?
  - Less extensive sponge and coral communities
  - More fringing mangroves, but less extensive mangrove forests
  - Freshwater wetlands in close proximity to the shoreline
  - Flow through transverse glades/creeks

Why is the Historical Context Important for MFL Development?

- Understanding how changes in freshwater flows have affected distribution and health of resources
- Determine which resources have likely been lost or degraded over time
- How long it takes for these resources to be impacted by, and recover from, adverse freshwater/salinity conditions.
- Knowledge of historical resources may help identify areas where similar resources can be successfully supported/re-established.

Summary

- Biscayne Bay is an altered system that is not likely to return to historical conditions; constraints imposed by current conditions will be considered in establishing MFLs.
- The Bay is a managed system and thus requires management goals that consider the full range of Bay resources that need to be protected.
- Failure to achieve restoration goals is consistent with the definition of “harm” to the system and is the basis for establishing reservations of water and for issuing consumptive use permits.
- By contrast, a degree of impact to an existing water resource that requires more than two years for recovery to occur is considered “significant harm” and is the basis for establishing an MFL.

Proposed MFL Approach for South Central Region

- Select one or a small number of key species such that…
  - The species is important ecologically
  - The species is sensitive to changes of freshwater inflows
  - The species viability may be significantly harmed by extremely low flows

Species	Ecosystem Importance	Low Flow Impact	Sum	Rank
American oyster (*Crassostrea virginica*)	2	2	4	**5**
American crocodile (*Crocodylus acutus*)	3	4	7	**3**
Blue crab (*Callinectes sapidus*)	3	5	8	**2**
Needlerush (*Juncus roemerianus*)	1	5	6	**4**
Pink shrimp (*Farfantepenaeus duorarum*)	5	1	6	**4**
Roseate spoonbill (*Ajaia ajaja*)	1	5	6	**4**
Shoal grass (*Halodule wrightii*)	5	4	9	**1**
Snook (*Centropomus undecimalis*)	3	4	7	**3**
Spikerush (*Eleocharis cellulosa*)	1	5	6	**4**
Tarpon (*Megalops atlanticus*)	3	3	6	**4**
Wigeon grass (*Ruppia maritima*)	3	5	8	**2**

Example: Species can be assigned scores that might reflect contribution to ecosystem vibrancy and possess salinity sensitivity to the viability of annual populations.

Most Suitable Species for South Central Biscayne Bay

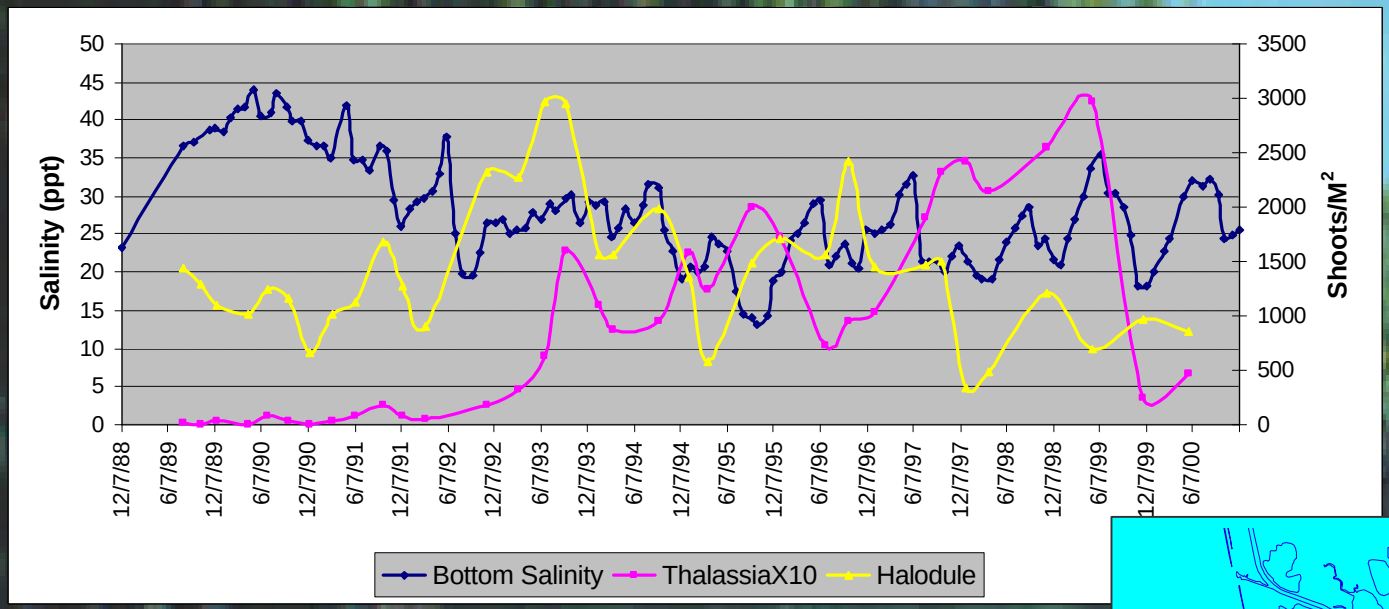
1. *Halodule wrightii* (Shoal grass)
2. *Ruppia maritima* (Wigeon grass)
3. *Callinectes sapidus* (Blue crab)

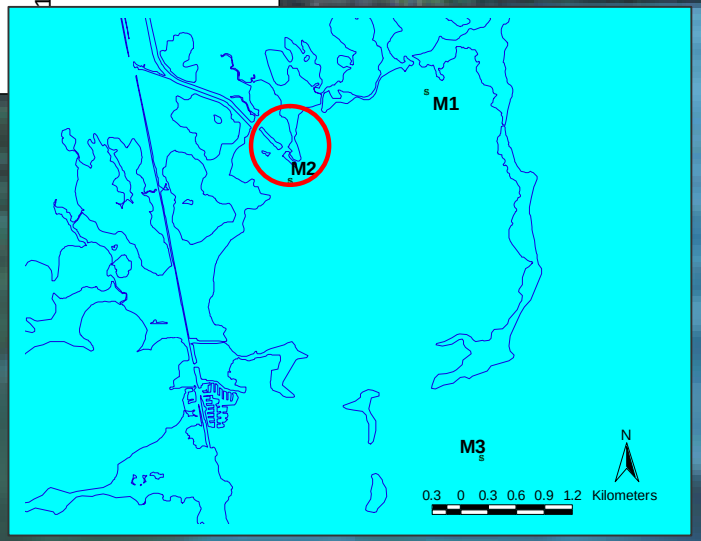
Why *Halodule*?

- Present in nearshore area
- Provides important habitat
- Represents diversity
- Susceptible to salinity perturbations
- Risk to recovery if lost

Example: *Halodule* density in Manatee Bay (Station M2)

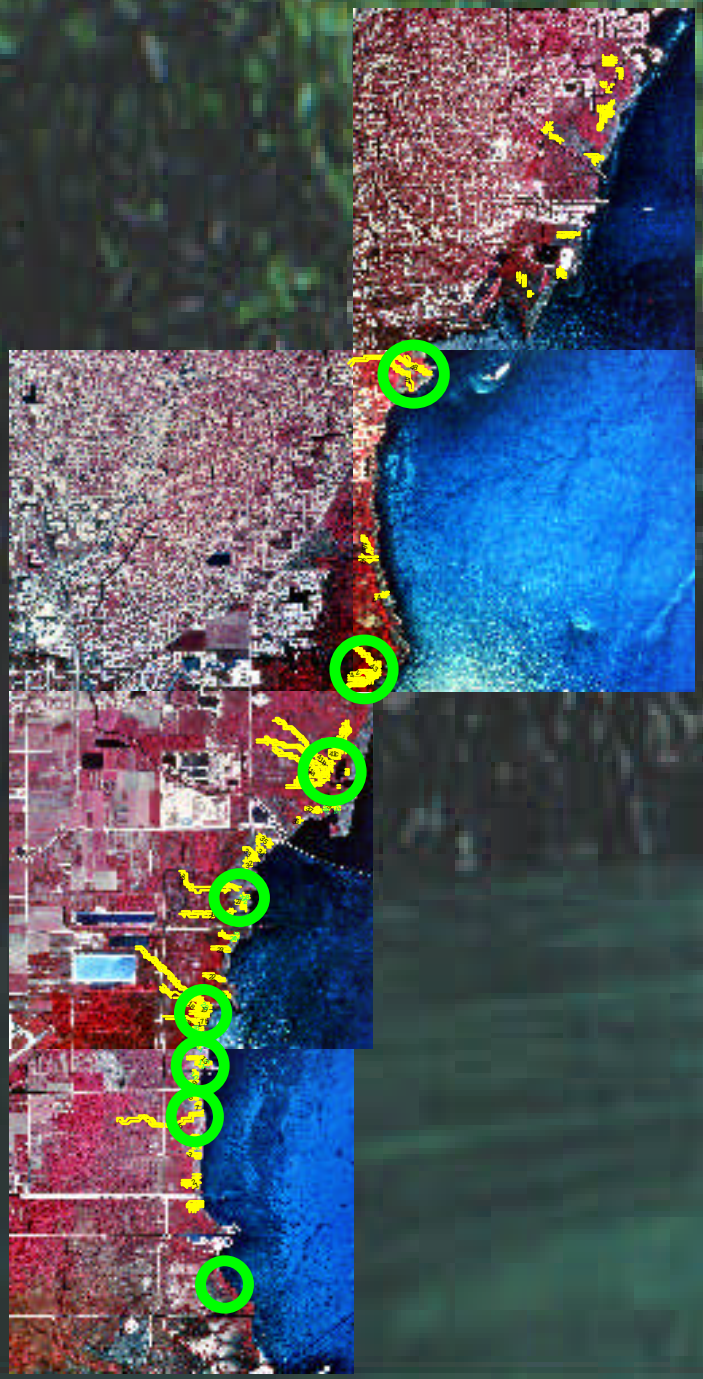
Source: M-D DERM





The Case for MFLs

- Protect existing resources.
- Investigate the relationships of species and different freshwater flows.



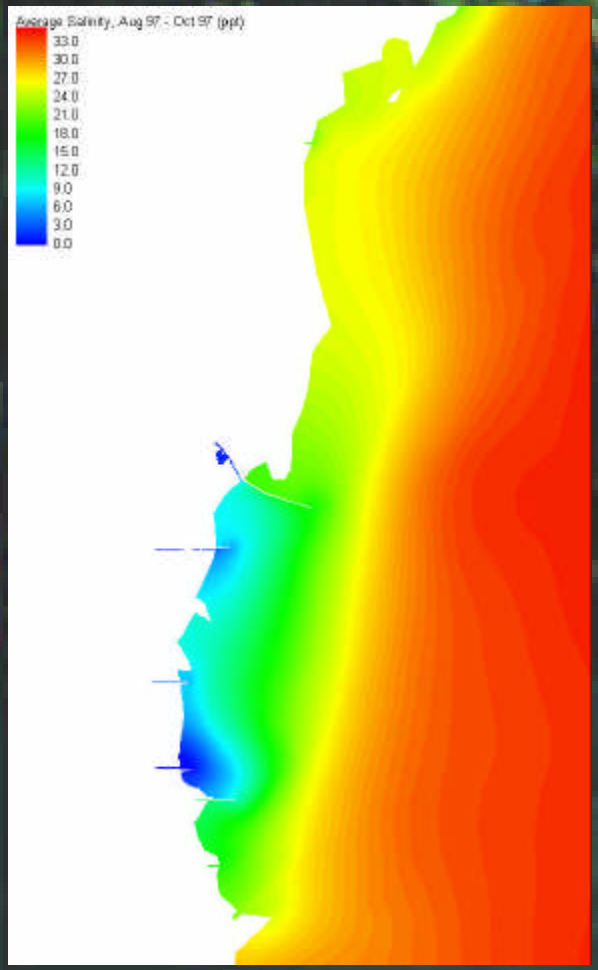
Alternatives to investigate may include examining the benefits of establishing dry period refugia. Conceptually, available water would be preferentially delivered into strategic areas of coastal wetlands to maintain populations of key species.

Possible management alternatives

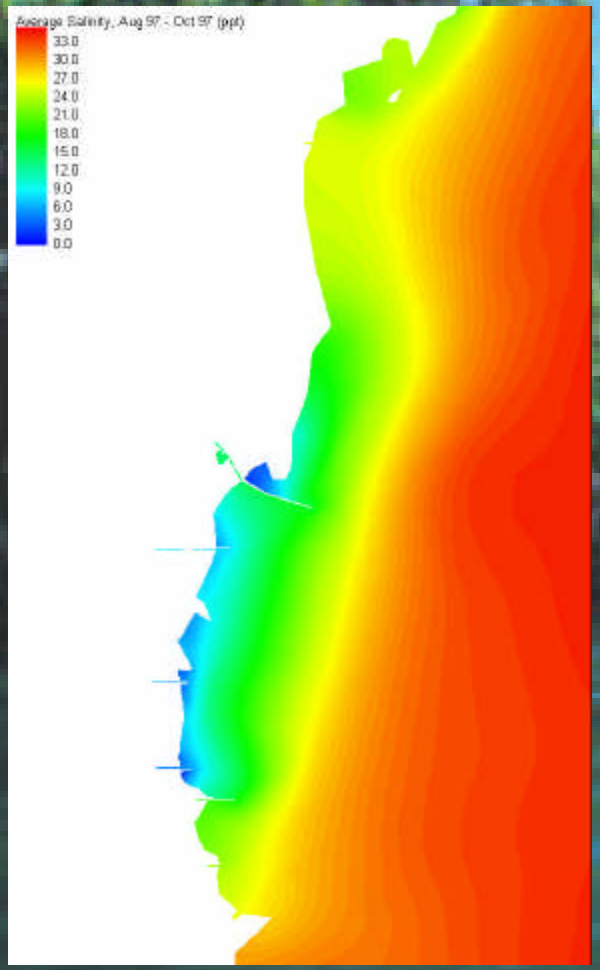
- Refugia zones
- Flow redistribution
- Supplemental supply
- Operational changes

Possible MFL Alternative: Redistribution

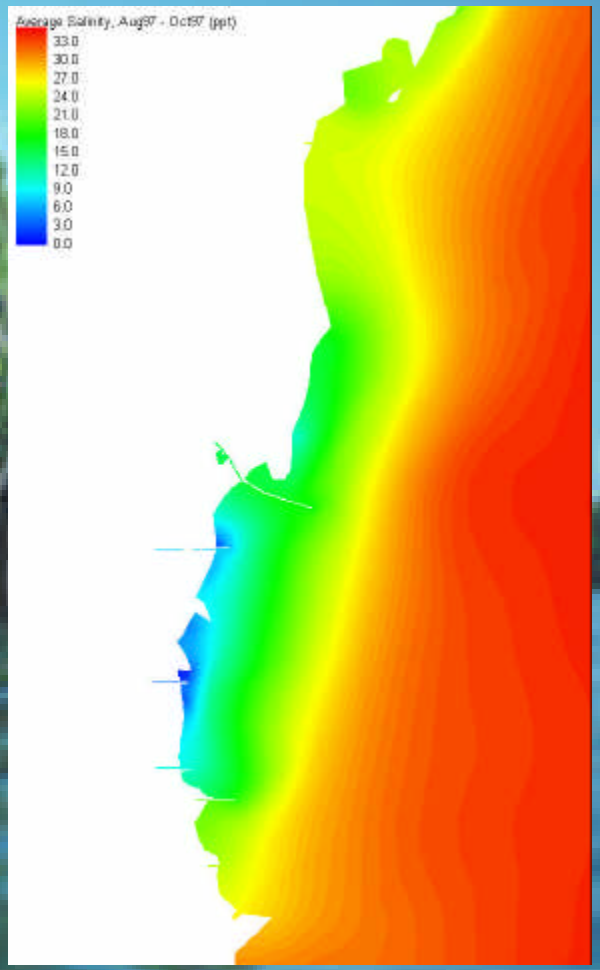
Mean salinity 9-10/97; Source: G. Brown, USACE, 2003



Existing Canals



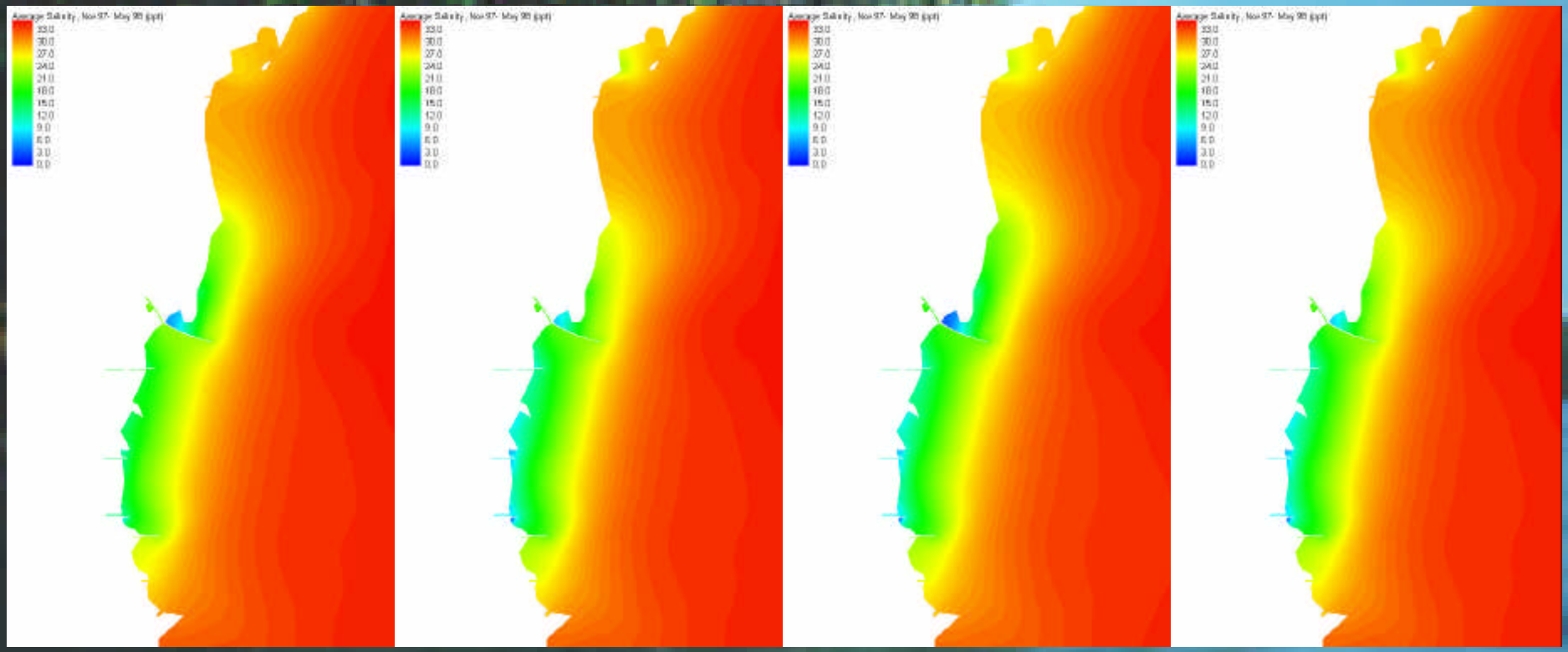
21 Creeks



8 Creeks

Possible MFL Alternative: Storage and Supplemental Water

Mean salinity 11/97-5/98; Source: G. Brown, USACE, 2003



Existing flows

15K ac-ft of storage

85K ac-ft of water

15K storage + 7K water

Wrap Up

- Questions
- Consultant Report: January
- Technical Criteria Draft Report: May
- Peer Review: June
- Draft Rule: August
- Governing Board: December